8.1 Fruit Sampling and Maturity

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The definition of optimal maturity will vary depending upon the style of wine being made, the winemaker's definition of quality, the variety, rootstock, site, seasonal factors and viticultural practices. If the grapes do not contain varietal aroma/flavour characteristics or mature tannins at harvest these characteristics will not be evident in the wine. Due to the importance of fruit maturity in the ultimate wine quality, you must conduct field sampling of fruit in an objective and statistically acceptable manner. It is important that growers and wineries standardize grape sampling techniques because without standardization it is impossible to compare results. Analysis of all pertinent quality factors may be prohibitive both time-wise and economically; and it is unlikely you will discover any single index of maturity that can be indiscriminately applied to all growing conditions and all varieties. Because historical data for each area will be a critical factor in determining the optimal maturity of grapes, records should be kept for each vintage of maturity observations, sensory and chemical analysis, weather and condition of the fruit at harvest.

Grape Sampling

Sampling methods should provide samples representative of the fruit to be harvested. Sample distinct blocks within a vineyard separately. Collect proportional quantities of fruit from exposed and shaded locations in different parts of the canopy, at different heights on the vine and on opposite sides of the row. Avoid sampling from vines at the end of rows, irrigation rows and odd vines that are obviously different from the majority of vines in the block. Avoid sampling fruit with dew or wet fruit after a rainfall. Include secondary clusters in the sample only if they will be picked at harvest. Samples can be taken as berries or whole clusters.

Obtain a sufficient quantity of fruit to give a representative sample. With cluster sampling, collect at least 20 clusters from throughout the vineyard. The main disadvantages of cluster sampling are possible depletion of crop from repeated sampling and the difficulty of processing large samples. With berry sampling take 200-400 berries from a large number of vines. Take samples weekly beginning about three weeks before harvest. Sample more frequently as the anticipated harvest date becomes closer, particularly if there are changes in the weather that could affect ripening or fruit condition. The variance between the sample analysis and the winery analysis is smallest if a minimum number of berries are collected from a large number of vines. Berry sampling in various locations on the cluster may be significant in the case of larger clusters but berries from the middle of the bunch are acceptable in the case of varieties with small clusters, sampling alternate sides of the cluster. Maximum area for sampling size should be 5 acres (2 ha).

Sample Preparation

Prepare berry samples for analysis by crushing without breaking the seeds (seed breakage can elevate pH readings 0.2 to 0.3 units). This can be done by hand, taking care to thoroughly crush each berry. The juice, free run and press combined, is separated immediately from the skins and seeds then allowed to settle to remove suspended solids. Use this settled juice for analysis. Red grape samples can be left on their skins for 1-2 hours at room temperature before pressing if desired. This will increase the pH of the must and may more closely resemble commercial operations. The important factor is consistently measuring the juice the same way for each sampling and allowing the berries to reach ambient temperature before testing. Storing juice in a refrigerator for later analysis can precipitate potassium bitartrate and may affect the pH, TA and potassium readings.

Analysis of Total Soluble Solids (Sugar) in Grape Must

Sugars accumulate in ripening berries from veraison to harvest. Sucrose is produced in the leaves by photosynthesis and is transported to the berries through the phloem. In the berries, sucrose is inverted to glucose and fructose, which are the primary sugars present at harvest. The percentage of sugar in the juice is measured as soluble solids content and is commonly expressed as degrees Brix (or degrees Balling) or as grams of sucrose per 100 grams of juice (%). Conversion tables can be used to convert specific gravity to Brix. Several studies have shown no relationship between sugar levels and the accumulation of grape flavour compounds.

Most flavour compounds show most of their accumulation later in the ripening process when sugar accumulation has slowed, hence the importance of "hang time".

A hand-held Brix refractometer @ 0-32 % sugar (% soluble solids) with automatic temperature compensation (ATC) and ± 0.2 % accuracy is commonly used on a grape juice sample. Refractometers measure the refractive index of grape juice. The sample does not have to settle for measurement by refractometry and juice may be placed directly on the glass surface. A scale reading in % sugar is commonly used (w/w or brix or % soluble solids are other commonly used terms). For example 1^{o}Brix = 1 gram of sugar per 100 grams of solution or 1% sugar. Temperature correction to 20^{o}C is essential for an accurate reading if refractometers are not ATC (even with an ATC refractometer the temperature of your sample should be 17^{o} to 23^{o} Celsius for the most accurate results). Calibrate the refractometer to 0% using 20^{o}C distilled water. Use a 20^{o} Brix solution for calibration by weighing 20 grams sucrose (table sugar) and dissolving in 80 grams of distilled water at 20^{o} C. These must be weighed accurately to give true readings. These amounts are weight/weight **NOT** weight/volume. You should not add an amount of sugar to a volumetric flask and make it up to the mark with water or you will get falsely high results with your grape samples. Clean the prism of a refractometer occasionally with alcohol or methanol and use distilled water between juice readings, blotting dry with a clean, lint-free cloth between readings.

Hydrometers also give a measure of the specific gravity of a solution, which relates to the total soluble solids content of the grape juice. Specific gravity is the weight of 1 ml of solution divided by the weight of 1 ml of distilled water at 20^{o}C. Accurate, narrow range hydrometers (1-5^{o} or 1-10^{o} Brix units) subdivided to 0.1^{o} units are the norm. Inexpensive hydrometers, often covering a wide range such as 0-30^{o} and having scales such as 'potential alcohol', are not very accurate. A hydrometer gives slightly higher readings than a refractometer if suspended solids are present, therefore it is important to use well-settled juice.

The potential alcohol content of the fermented juice can be estimated by multiplying the degrees Brix on red musts by 0.55 and white musts by 0.60. Note that with raisined berries the initial sugar reading is low due to incomplete sugar extraction. During pressing and fermentation additional fermentable sugar is extracted.

Analysis of Acidity in Grape Must

Tartaric and malic acid represent about 90% of the acids in wine grapes. These acids are synthesized primarily in the grapes (as opposed to the vine itself). Malic acid is less stable with the sharp tang of green apples while tartaric acid is stronger and more stable. Wine grapes are unusual in that few other fruits accumulate significant quantities of tartaric acid. Both tartaric acid and malic acid increase rapidly in the berries prior to veraison. From veraison to harvest the tartaric acid content of the berries decreases due to the increase in berry size and then remains relatively constant during the later stages of ripening. Malic acid also decreases due to increasing berry size, however it is utilized as an energy source by the berries in respiration as well. The decrease in malic acid during the later stages of ripening is more rapid during periods of warmer weather. The tartaric/malic ratio varies with grape variety, the degree of ripening and environmental conditions during ripening. The overall net decrease in acidity during the later stages of ripening is primarily due to the decrease in malic acid content. Acidity is an important measurement for flavour balance and wine style and has a greater impact on the way the juice tastes than does pH.

To determine the total acidity of a juice sample, recorded as titratable acidity (TA), measure the hydrogen ions released when a juice sample is titrated with a standardized base to a defined endpoint using sodium hydroxide. Do this by accurately pipetting 5 ml of juice into 100 ml distilled water (at 8.2-8.4 pH) in a beaker. This is then titrated with standardized 0.1 N NaOH using a calibrated burette to a neutralized endpoint of 8.2 to 8.4 pH. The number of milliliters (ml) of NaOH used is multiplied by 1.5 to equal the TA in grams per litre (divide by 10 to give percent acidity or g/100 ml) of tartaric acid. Typically wine grapes range from TA 5.0-10.0 g/litre tartaric acid at harvest with winegrapes from warmer sites or warmer seasons having lower TA levels than wine grapes from cooler sites or cooler seasons. TA can also be simply expressed as the volume of NaOH required to neutralize a sample. In some countries the percent acidity (g/100 ml) is expressed as sulphuric acid. This percent, multiplied by 1.5, approximately equals the percent acidity expressed as tartaric acid. Tartaric and malic acid can also be measured separately by colourimetric, enzymatic and chromatographic methods.

Analysis of pH in Grape Must

Measurement of pH is one of the most important laboratory procedures. Changes in pH are not necessarily a function of berry maturity and relate to potassium and vigour. pH is responsible for microbiological and chemical stability, colour, SO_2 equilibrium and effectiveness, plus other oenologically significant factors. pH is a measure of the free hydrogen ion concentration and is an intensity aspect (as opposed to TA which is a quantity aspect). It is a direct measure of the total hydrogen ion content in solution and is expressed on a scale of 0-14 units. A solution with a pH of 7 is a neutral solution, having an equal number of acid and base ions. As the pH decreases below 7, the acidity increases; as the pH increases above 7, the acidity decreases and the solution becomes more basic. A change of one pH unit represents a tenfold change in concentration of free hydrogen ions. Thus, a juice with a pH of 3.0 has ten times the acid intensity of a juice with pH 4.0. The desired pH levels at harvest range from 3.10-3.50. Wine grapes from warmer sites or warmer seasons have higher pH values than wine grapes from cooler sites or cooler seasons.

To determine the pH on settled grape juice (without dilution, refrigeration or freezing) a pH meter with accuracy of a least ± 0.05 pH units is required. Carefully calibrate the meter prior to each use with standard pH 4.00 and pH 7.00 buffer solutions. It is desirable for the pH meter to have automatic temperature control (ATC). Whether or not temperature control is available, samples tested, as well as buffers, should be close to 20° C. A temperature correction table is required for meters without ATC. Because grape solids can clog the electrodes, thus impeding the flow of ions, it is critical to clean electrodes regularly and properly. The most common error is the use of worn or insensitive electrodes.

Analysis of Fermentable Nitrogen in Grape Must

Yeast requires nitrogen compounds for the production of cell biomass and the synthesis of proteins and enzymes necessary for fermentation. The readily fermentable nitrogen compounds in juice consist primarily of ammonia and alpha-amino acids with the total of these two compounds called YAN or YANC (yeast-assimilable nitrogen content).

From veraison to harvest, the ammonia concentration in the pulp of the berry decreases at the same time the amino acid content significantly increases. In unripe fruit the ammonia content may represent up to 50% of the pulp nitrogen, whereas at full maturity the amino acid content may represent up to 90% of the pulp nitrogen. The pulp of mature berries contains up to 20% of the total berry nitrogen, with the remainder distributed in the skins and seeds. Fermentable nitrogen content affects the fermentation rate and deficiencies may produce sulfide odours, contribute to slow or stuck fermentations and accelerate wine aging.

You can measure the ammonia content with a spectrophotometer at 340 nm using an enzymatic ammonia diagnostic kit or by using an ammonia ion selective electrode. The enzymatic test has the advantage of being fast, accurate and inexpensive (provided you have a UV spectrophotometer). You can also measure the alpha-amino acid content by spectrophotometric assay as well. This assay is called NOPA for 'nitrogen by OPA' and is reliable and fast. Add the ammonia and alpha-amino acid readings together to determine a YAN reading. Recommended levels of YAN needed for healthy fermentations are 200-300 mg N/litre (the higher the sugar content and riper the grapes, the more nitrogen required).

Variations in climate, soil, cultivation practices, soil moisture content and fertilization practices may have a significant impact on juice nutrition. Excess nitrogen (from fertilization) on mature vines can lower the vines resistance to sun damage and fungal disease. Low nitrogen levels may cause fermentation and wine aging problems and winemakers often add supplements to juice and fermenting wines to balance nutritional deficiencies. These supplements may include diammonium phosphate (DAP), yeast extracts and vitamins. Moderate nitrogen supplementation of deficient musts may also increase fruit aroma intensity and wine quality, particularly in white wines, while excessive additions may lead to increased formation of ethyl carbamate.

Grape Seeds

Seed colour is another useful and easily determined index of maturity. During fruit maturation, seeds mature at a different rate than the accumulation of sugar. As seeds mature they change colour from green to brown to dark brown. The brown colour is caused by oxidation of the tannins as they become fixed to the seed coat and thus less extractable during fermentation. This is particularly important in red wine production where tannins are extracted from the seeds and skins. Seed tannins make up over 60% of the total tannin concentration. Unripe seeds mean immature, readily extractable seed tannins that result in harsh or hard wines whereas ripe seeds give soft and supple, less bitter or harsh tannins. Changes in seed tannin occur late season when it appears that no additional ripening can take place. Seed tannin astringency changes little with time. What does change is the extractability of these compounds into the wine.

Some winemakers taste seeds to assess grape maturity, however, seed bitterness may be overpowering and many individuals may not be able to accurately discriminate levels of seed bitterness. Physical characteristics of the seeds – colour, texture and brittleness – may be more important indicators of seed maturity.

Grape Colour

Colour in grapes is derived from increases in anthocyanins and biosynthesis during ripening, therefore grapes become more uniformly coloured with maturity. Wine colour is predetermined by the levels of anthocyanin pigments and other non-coloured phenolic components in the grapes and is little affected by winemaking practices. These anthocyanin pigments are present in the skins and normally the pulp or juice is not coloured. When grapes are heated by fermentation (or heat extraction) these peripheral cells are killed and the pigment is released into the pulp, aided by mixing, which facilitates pigment diffusion into the juice. With some red varieties (i.e. Pinot Noir) if the grapes are pressed without skin contact, then a white wine is produced. Conversely, pink or light-red skinned varieties of so-called white grapes (i.e. Gewurztraminer or Pinot Gris) are allowed limited or no skin contact to avoid 'pink' coloured wines. Pigmentation of skins is greater in cooler temperatures and in areas with greater temperature contrasts between day and night. Excessive nitrogen decreases colour.

Red wines will progress in colour development from light red to medium red to ruby to black-red.

White wines will progress in colour development from dark green to light green to gold.

Aroma/Flavour and Phenolic Compounds

The physiological mechanism the vine uses to make sugar is not the same as used to produce secondary metabolites such as aroma, flavour and phenolic compounds. You can have low sugar and a high concentration of varietal aroma and flavour or the opposite. Grape-derived aroma and flavour compounds present in the grape skins and pulp are the principle source of wine aroma, flavour and taste. They are the most important fruit attributes contributing to wine quality and should be considered a part of any grape maturity evaluation. If grapes are harvested when varietal character is lacking then this character will be absent or reduced in the finished wine. Phenols are present in grape skins, seeds and stems as well as barrels and tannin additions. Grape phenols have a significant influence on wine structure including body, tannin intensity, astringency, bitterness and dryness. As fruit matures, their phenolic compounds bind together or polymerise.

This polymerisation causes a sensory change from 'hard' and 'bitter' to astringent and finally to soft and supple.

Excessive herbaceousness results in a reduction in fruit intensity. Herbaceousness is mainly derived from pyrazines. Methoxypyrazines are nitrogen-containing compounds present in green plant tissue, including grape berries. Concentrations range from 0 to 35 mg/L. Pyrazines decrease following veraison. This decrease is directly correlated to the decrease in malic acid. Malic acid decreases at a faster rate during warm night time temperatures as do methoxypyrazines. High soil moisture delays fruit maturation and the reduction of methoxypyrazines and over-irrigated/over-fertilized vines produce grapes lacking flavour and colour. Increased sun exposure increases the rate of grape maturation and the reduction in methoxypyrazines. As well, canopy management can have a dramatic effect on aroma and flavour development. Crop load (either too high or too low) also impacts these compounds and excessive crop to leaf area can delay the rate of fruit development. The presence of methoxypyrazines increases the perception of tannin intensity, astringency and tannins, thus magnifying the sense of acidity.

Botrytis Bunch Rot or Sour Rot

The incidence of Botrytis bunch rot and/or Sour Rot complex is important to distinguish. The fungus *Botrytis cinerea* causes Botrytis bunch rot and a complex of bacteria along with fungi causes Sour, grey or vulgar rot. The external development of rot is not an accurate indicator of internal damage to the berry. Transformations are already well advanced at the first sign of the characteristic brownish stains, which are clearly visible on white grapes and less so on very dark red grapes. The surface of sour rot-infected grapes appears black, brown, or green and less fuzzy than Botrytis-infected grapes. Also, grapes infected with sour rot give off a pungent, vinegar smell and tend to attract fruit flies. It is important to correctly diagnose which one is causing problems for fungicide use as well as harvesting considerations. *Botrytis cinerea* or 'noble rot' increases quality and is often desirable for 'botrytis-affected wines'. 'Sour rot' decreases quality and 0% is preferred and above 8% is unacceptable for reds and above 5% is unacceptable for whites. With sour, grey or vulgar rot the Brix will decrease, the TA will decrease and the pH will increase over unaffected grapes. With noble rot the Brix will increase, the TA will decrease and the pH will increase over unaffected grapes. Botrytis bunch rot and Sour rot infected grapes have reduced ammonia nitrogen available for yeast metabolism and require supplementation to avoid stuck fermentation and possible sulphide formation. As well infected grapes form polysaccharides that create clarification problems for the winemaker and excess laccase that can cause oxidation. Tighter clustered varieties are more prone to infection then loose clusters.

Ideal Noble Rot Characteristics

- Grapes should be mature;
- Morning mists followed by warmth, in well-drained soils, will enable the grape to dry out;
- The fungus penetrates through the skin to the pulp without bursting it. The skin is literally digested and no longer acts as a screen between the inside and outside of the berry. The berry acts like a sponge and eventually dries out and the contents become concentrated by water evaporation. The osmotic pressure inside the berry increases and the metabolic activity of the fungus decreases and death of the fungus occurs before it is able to cause spoilage.
- The production of glycerol and the ratio of glycerol/gluconic acid is a good indicator for judging the quality of the botrytis as it is the highest in the case of noble rot.
- With noble rot, the phenolic compounds are totally oxidized in the grape and wines are less sensitive to oxidation.
- Noble rot leads to an improvement in quality with increase in sugar, deacidification and production of distinct aromas.

Ideal Sour, Grey or Vulgar Rot Characteristics

- Damp conditions do not allow the rapid dehydration of the berry. The metabolic activity of *botrytis cinerea* continues with the intervention of other fungi and bacteria characterized by aromatic degradation. The berry may eventually burst if there is too much humidity. The inhibition of botrytis may cause the development of *gluconobacter* and the production of acetic acid.

- With this rot, the oxidation of phenolic compounds is not totally oxidized in the grape and oxidation will be more pronounced.
- Is more prevalent in the world than noble rot with dense canopies more conducive to its production.
- Sour rot leads to deterioration in quality with decrease in sugar, deacidification and production of distinct sour aromas.

Other Visual Observations on Fruit Condition

When sampling grapes the following should be assessed and noted:

- The incidence and amount of powdery mildew (greater than 10% is unacceptable). Indications include grayish, powdery residue on grapes; reddish-brown or black areas on last years' canes; whitish or green-white patches on young leaves and mottled, blistered effects on older leaves.
- Mould
- Sunscald on bunches
- Hail damage
- Fruit flies (often present at site of an infection)
- Wasp/Bee damage (juice sucked out of individual berries leaving a collapsed, brown berry with puncture holes evident)
- Insecticide, fungicide, or herbicide residues on the grape bunches. These can also cause winemaking problems and spray applications close to harvest should always be approved by the winemaker.
- Shrivelling or dehydration of bunches
- Collapsed or limp bunches
- Berry shatter (loose berries which easily detach from the stem)
- Softening of berries and thinner skins (berries reach maximum size during ripening then begin to soften at full maturity)
- Bird, bear, deer or other animal damage. Remember, the function of the berries is to attract animals for dispersal of grape seeds.
- Change in stem or pedicel colour. Stems and pedicels (the stems which attach the flowers/berries to the bunch) undergo a change from green, vegetal and unripe to brown, woody and ripe to brittle, herbal and over-ripe. These changes are varietal specific and in some varieties the stems never ripen beyond the green stage.
- Wet vines, bunches or cover crops due to excess irrigation. This can dilute readings and delay maturity.
- Atypical changes in leaf colour or texture or premature drop of leaves.

Varietal quality of grape aromas will progress as follows:

Off ⇨ Mediocre ⇨ Pleasant ⇨ Distinctive of the cultivar ⇨ Exceptional

Varietal character intensity will progress as follows:

Neutral ⇨ Slight ⇨ Moderate ⇨ Intense ⇨ Very intense

Changes in Grape Aromas / Flavours

Vegetation ⇨	Herbaceousness ⇨	Unripe Fruit ⇨	Red Fruit ⇨	Black Fruit ⇨	Jam
Plant matter Green, grass	Straw, herb, vegetal, tobacco	Green apple, Citrus rind	Cherry, Strawberry, Raspberry, Cranberry, Blackcurrant	Plum, Blackberry, Black cherry	Prune, Date, Raisin

Weather

A cool autumn slows down development, better balances can be achieved and more aroma and flavour constituents are accumulated. Cool climates generally produce the best quality table wines and evidence suggests that it is the lower temperatures in the autumn that are of special significance. In warm climates ripening of grapes occurs early, when the weather is still warm or hot. These hot conditions cause rapid development of sugars, rapid loss of acids and high pH's. The juice is often unbalanced and the grape appears to have had insufficient time to accumulate those many chemical compounds that add distinction to wine.

Further ripening potential is often weather dependent and consideration should be given to extremes of weather that can delay or arrest maturation of the grapes:

- excess heat or drought can cause premature berry shrivelling (dehydration);
- excess rain can cause berry swelling and dilution;
- cold weather can arrest maturation;
- warm years and smaller crops drive sugars up faster than the rate of ripening of the tannins/ acids and pH's, creating less than ideal balance with high alcohol levels;
- cool years and larger crops delay sugar accumulation and respiration of malic acid giving low sugars, high acidity and low pH's as well as herbaceous flavour and low alcohol levels.

To review the latest weather forecast and historical weather information for your area check out this internet site: http://www.weatheroffice.ec.gc.ca/

Historical Index of Ripeness

The following formulas have been utilized historically to determine grape maturity:

1) **Brix x (pH)^2**
   – optimal ripeness is in the range of 220 to 265 for table wine. (Late Harvest over 270)

OR

2) **Brix ÷ TA (g/100 ml)**
   – optimal ripeness is in the range of 30 to 32 for table wine. (Late Harvest over 36)

However, the sugar-acidity ratio is quite variable across different varieties and growing conditions as well as year-to-year, therefore these universal rules may not predict the value for wine quality. As well, it is not clear whether the optimal sugar-acidity balance always coincides with optimal maturity of grape flavourants.

Sampling Abnormalities

During Grape ripening, normally sugars increase, pH's increase and TA's decrease to optimum maturity. Occasionally the reverse will happen. Possible reasons are:

Sugar Decreases

- Previous sampling not representative or sampling method differed or analysis methods changed;
- In very hot seasons grapes may catabolize sugar if malic acid levels decline too much;
- Sampling unusually high solids juice;
- Rainfall or excess irrigation;
- Incomplete sugar extraction due to raisining (dehydration);
- Sour rot occurrence.

pH Decreases or TA Increases

- Previous sampling not representative or sampling method differed or analysis methods changed;
- Sampling unusually high solids juice; Rainfall or excess irrigation.
- Nitrogen application may increase TA due to higher malic acid which rises on application of nitrogen.

Grape Harvest Trivia

- In a 'normal' year it takes about one week for grapes to accumulate one degree of brix or 1% soluble solids.
- Riper berries are found on the top and shoulders of the cluster and the least ripe are near the bottom tip.
- There is an initial rapid phase of sugar accumulation then the vine ceases transport of sugar to the fruit and further sugar increases are due to dehydration. Natural sugar accumulation stops at somewhere around 25^o Brix.

- The smallest berries attain the highest sugar concentrations while larger berries have a much lower sugar concentration.
- Glucose predominates at veraison but by harvest fructose and glucose are about equal in proportion. Fructose is the sweeter of the two and may exceed glucose in overripe berries.
- In some poor sugar-developing seasons, such as cool, cloudy or rainy summers, flavours may reach their peak before sugar reaches the desired level.
- Colour and varietal flavour may develop at lower sugar levels during cool ripening seasons compared to warmer vintages.
- Too much heat or drought during later stages of ripening can delay physiological maturity and cause excessive dehydration and shriveling, resulting in abnormal sugar increases due to a concentration effect rather than grape maturation.
- Raisined berries will give a low initial sugar reading due to incomplete sugar extraction. During pressing and fermentation additional fermentable sugar is extracted.
- In a very hot season grapes may catabolize sugar if malic acid levels decline too much.
- Using only free run juice for analysis gives higher sugar and TA and lower pH and potassium readings than a free run/press juice sample.
- Actively growing shoot tips can draw sugars away from ripening bunches so that sugar accumulation is slowed, flavour development reduced and pH is increased in the berries.
- On average, a leaf area of 8-14 cm^2 (single canopy) and 5-8 cm^2 (double canopy) per gram of fruit produced is required to adequately ripen a crop to specification.
- Grapes with high acidity and high pH will also have high potassium, high malic acid content, poor colour and probably excessively vegetative aromas.
- Overripe grapes or a warm climate can result in high pH and low TA due to the respiration of organic acids; immature grapes or a cool climate can give low pH and high TA due to the high level of non-exchanged organic acids. A very long ripening period in a cool climate results in both high pH and high TA.
- Excessively light crops on high capacity vines and sites will produce higher pH at optimum sugar levels.
- The pH of irrigation water can affect grape pH.
- After veraison the pH will rise if there is significant potassium uptake at the same time as acid respiration; pH will fall if there is faster production of malic and tartaric acid in the berry than potassium uptake, for instance after a rainfall or irrigation.
- The amount of potassium increases during ripening, especially in the skins, and is by far the most abundant mineral in grapes.
- Tannins are highest in skins and almost equal in stems and seeds. There is no difference in tannin levels of seeds in white or red grapes.
- Wine grapes have an average of 4 seeds/berry thou 2 or 3 seeds is not uncommon.
- As grapes ripen, tannin levels of seeds may decrease, but later, as skins ripen, tannin levels may increase again.
- Tannins that have bitterness attributes are derived from seeds not skins.
- A balanced wine is achieved when only 15% of the available tannins are extracted.
- Provided that the TA or pH levels are not so high that acidity adjustments are compromised, or sugar levels so high the resultant wine will be too alcoholic, than flavour intensity is usually the prime consideration when deciding on the harvest date.
- You can best assess optimal maturity by monitoring levels of grape flavourants. You can taste berries, however, often tasters are looking for the absence of herbaceousness rather than the presence of flavourants.
- Phenolics include compounds that contribute colour, astringency and flavour to wine. Increased light incidence (longer daylight hours) on berries stimulates the production of phenolics.
- Loss of character can be quite dramatic following rainfall late in berry ripening and berry weight may increase through hydration.
- Muscat varieties have the strongest *vinifera* aroma due to a distinctive mixture of volatile acids, alcohols, esters, terpenoids and other compounds.

- Sample preparation best approximates commercial processing at a yield of about 65 ml/100grams. This corresponds to about 600 litres/short ton.
- You can use one of two techniques to select berries for sampling. No difference in accuracy has been noted between the techniques. First is to select only berries from the middle portion of the cluster. These will be intermediate in their maturity. Second is to alternate between selecting a berry from the top, middle and bottom of the cluster. The key here is to avoid taking all the berries from the top and shoulders, since this may give a higher Brix reading than exists in the vineyard.
- Depending on the duration of the bloom period and fruit set, the range in maturity among berries on a cluster and among clusters on a vine may vary by up to two weeks. Berries on the inside of clusters are less ripe than outer berries.
- Younger vines will generally achieve optimum readings at an earlier date than when they become mature vines.
- Berry samples tend to show greater ripeness then the actual must composition in a winery.
- Larger berries have more seeds and a lower skin to pulp ratio by weight, whereas smaller berries have fewer seeds and a greater ratio of skins to pulp. Grape skins are the principle source of aromatic compounds and flavour precursors. Seeds are the principle source of phenolic compounds. Pulp is the primary source of sugars, acids, mineral cations, nitrogenous compounds and pectic substances.
- Within a grape berry, the pulp will mature first, the skin second and the seeds last.
- In a 'normal' year it takes about one week for the grape crop to increase about 5% in weight.
- At dehydration the average berry weight decreases while sugar increases. Dehydration can decrease average berry weight by 5-10%. Wines produced from grapes harvested at this dehydrated stage usually have an increased concentration of colour, aroma and flavour.
- Photosynthesis declines rapidly above 30^{o} C (86^{o} F) and falls to nearly zero at 45^{o} C (113^{o} F).
- Grapes are subject to a fairly common 'accident' in fruit setting called "millerandage" in French, which, as a result of poor flowering conditions, leads to the development of normal sized and very small, seedless berries within the same bunch of grapes. These very small berries are sweeter than normal sized berries and failure of these berries to size causes yield reductions.
- Sunscald causes grape berry surfaces to become brown and possibly shriveled. These symptoms appear on the portions of the cluster exposed to direct sunlight. This injury often occurs when fruit that has developed in shade is exposed to direct sunlight, such as when leaf removal, summer pruning, shoot positioning or other canopy management practices occur in mid to late season. Fruit exposed to sunlight for the entire growing season may also develop sunscald when drought conditions develop. Fruit damaged by sunscald may develop various fruit rots and deteriorate further.
- Unripe fruit has green juice because of high chlorophyll content and low pigment content in the skins. At full maturity, white grapes have light yellow to golden juice; red grapes have red to purple juice. It is easier to extract pigments from more mature fruit.
- Nitrogen (measured as YAN) can vary year-to-year in a vineyard depending on weather (rainfall, temperature, etc.), irrigation, fertilization, crop load, etc.
- The breakdown of grapes after harvest due to oxidation, enzymatic activity and wild yeast activity is directly related to both grape temperature and length of time between harvesting and processing.
- Reduce berry damage at harvest by minimizing the transfer of grapes from one container to another and utilizing shallow containers to reduce pressure on the berries.
- From a winemaking perspective, the closer the harvested fruit to the target Brix and TA, the less juice manipulation has to be done in the tanks to produce a consistent product and hence the less money spent and the more natural the product.
- One 750 ml bottle of wine is equivalent to 2.3 pounds of grapes

8.2 Harvesting Techniques

Grape Scheduling

The harvest is a busy time for wineries. Scheduling is critical to ensure the grapes arrive at a time when cooperage is available. Growers also are busy and require advance notice for harvesting to arrange bin arrival and to have adequate pickers on hand. It is therefore important that good communication take place between the winery and grower throughout the harvest. Grower and winery should agree on delivery times and tonnage to ensure effective use of resources.

After spending the summer producing quality of grapes in the vineyard it is important to harvest in a manner that ensures the grapes are delivered to the winery in the best condition possible. The quality of the grape begins to decrease as soon as it is picked. The rate of decline is dependent on how it was picked, the care taken when picking and the temperature of the fruit.

The decision on whether to hand or machine pick is dependent upon the variety, the vineyard terrain, the grape intake schedule at the winery, the condition of the vines, the weather, the availability of labour, and the capacity of the vineyard. Hand picking requires large numbers of employees in order harvest the grapes in an efficient manner, and must be completed in the day during cool temperatures. Winemakers prefer hand harvesting for certain varieties. Machine harvesting requires a large capital investment if purchasing a harvesting machine. Contract harvesters are also available as an alternative to purchasing or leasing a machine. Machine harvesting requires a small crew and picks at the equivalent of 40 to 50 hand pickers. Machine harvesting can also be completed at night.

Hand Picking

Hand picking is performed using baskets, buckets or wheelbarrows and dumping into a bin. The bin should be clean and positioned convenient to the picker. Picking is usually carried out using picking clippers. The bunches should be cut loose and not pulled from the vine. Handle the bunched as gently as possible so that it ends up in the bin looking as it did on the plant. Crushing and juicing the bunches especially in white varieties can have adverse effects on the quality of the wine. This is particularly a concern early in the fall on warm days. Remove all leaves branches and material other than grape (MOG) from the bin during the filling process.

Store full bins out of the sun or covered with lids. Shipment for processing should occur as soon as possible once the grapes have been picked.

Payment varies depending on the crop. The Provincial Government publishes the minimum payment per bin each year. If the crop is quite light, payment by the hour or increased payment per bin may occur.

The following website will give you information on piece rates http://www.labour.gov.bc.ca/esb/facshts/farm_worker.htm#piece_rates.

Mechanical Picking

Mechanical picking requires good harvesting equipment, straight rows, minimum fruit around the posts and the fruit positioned in a constant fruiting zone.

The harvester straddles the row and vibrates the grapes from the bunches. A tractor with a bin runs with the harvester collecting the grapes. It is very important to have a knowledgeable and experienced staff for machine harvesting. Inexperience can lead to loss of yield, damaged canes and posts, and increased MOG in the harvest grapes.

Mechanical harvesters can operate in the cool part of the day or night with minimal crew requirements. The scheduling of grapes for delivery at the winery is more reliable with machine harvesting. It is important to remove secondary clusters in the fruiting zone or diseased fruit prior to machine harvesting. Machine harvested grapes should be delivered to the winery and processed as soon as possible. (Machine harvested grapes have a significant amount of juice in the bin and must be processed very quickly.)

Mechanical picking costs are substantially lower, running 20% of hand picking costs.

As acreage increases in the Okanagan and Similkameen mechanical harvesting may be the main method used.

8.3 Food Safety

Introduction

This section of the production guide is a preliminary description of food safety in the production of grapes. Food safety is becoming more important for consumers, retailers and governments. Retailers are looking for traceability and quality systems to track contaminated food products, and identify and control food safety issues. Federal and provincial governments have recently announced that food safety will be an item for new agricultural programs to focus on. Adopting safe food production and handling methods at the farm level is a priority with federal and provincial governments. For additional information on food safety, refer to this website:
http://www.al.gov.bc.ca/foodsafety/programs.htm

What is a Food Safety Risk?

Food safety is related to the physical, chemical and microbial conditions or influences under which food products are grown, harvested, stored and transported to food markets.

A food safety risk is a site condition or operational factor, which creates the potential to affect the safeness of your produce in a negative way. All risks ultimately have the potential to affect the health of the consumer by causing food-borne illness. Food-borne illness occurs when a person gets sick by eating food that has been contaminated with unwanted micro-organisms or bacteria.

You are required to adhere to pesticide labeling and regulations in the selection, storage and handling of chemical products. Chemical food safety factors include:

- Only use chemicals registered for the intended crop
- Calibrate equipment regularly
- Observe the required interval between application and days to harvest
- Keep records of applications
- Thoroughly wash sprayers and mixing containers between chemical applications.

You can reduce physical food safety hazards by taking steps to minimize the chances that foreign materials, such as metal, glass and jewelry, may contaminate fresh product.

Ways That Fresh Product May Acquire Food Borne Illness

The most common ways of contaminating grapes with food borne illness are: by direct contact with water containing microbial hazards; direct contact with animal manure or faeces; passing of pathogens by workers to produce during handling; and contact of produce with microbial hazards in the field, food facilities or on vehicles, machinery and equipment. In addition, microbial hazards may be carried or transmitted to fresh produce by pets, birds, insects, and through the air.

Use of Water

Wherever water comes into contact with fresh produce, water quality determines the potential for microbial hazards to be present. The food safety objective in using water is to use good quality water at the outset and to minimize the risk of cross-contamination. Food safety risk is minimized by adopting practices to protect water quality, minimize the potential for contaminated water to contact the produce, and using procedures which monitor and detect potential water-borne threats to food safety on the farm.

Use of Manure

While composted manure and produce waste are desirable sources of organic fertilizer and soil conditioner in tree fruits production, respectively, they are also significant sources of microbial hazards when stored, handled and used. Reducing food safety risks can be attained by: using manure or produce waste in a manner that prevents cross-contamination of water; adopting practices which minimize the potential for raw manure and produce waste to contact fresh tree fruits; and using procedures which monitor and detect potential manure-borne and produce waste threats to food safety on the farm.

Worker Hygiene & sanitation

Farm workers can be a source of microbial hazards for grapes. The micro-organisms are spread to produce through the use of unsanitary materials and equipment, improper hygiene, and ineffective sanitary measures. The most effective way to combat worker-borne contamination risk is through education, training and supervision of workers who handle produce.

Orchard, Facility, Vehicle, Machinery & Equipment Sanitation

Poor management of materials, machinery and equipment on the farm can significantly increase the risk of exposing fruit to microbial hazards. The food safety objective is to start with clean materials, machinery and equipment; use practices which minimize the potential for cross-contamination; and monitor and detect potential hazards before they affect the food safety of your produce.

Good Agricultural Practices Reduce Food Safety Risks

Good agricultural practices (GAPs) can reduce the potential for microbes to contaminate fresh tree fruits. GAPs over which producers have control include:

- Maintaining proper temperatures at all times to ensure quality and safety of produce
- Ensuring that on-farm food facilities are of sound construction and kept in good repair
- Maintaining overall farm cleanliness and good sanitary practices
- Supervising the hygiene and sanitation practices of workers
- Having a supply of potable water readily available to your workers for washing and drinking
- Minimizing the potential for water contamination in irrigation, especially close to harvest, by using good quality water and preventing contaminated water from coming into contact with the edible product
- Taking precautions to ensure that manure storage and handling facilities are operating properly
- Handling manure and produce waste with the understanding that application to cropping areas of manure treated by composting poses a lower microbial hazard than does raw manure
- Ensuring that the traffic flow of vehicles, workers and produce on the farm avoids sources of microbial hazard
- Keeping accurate records of food safety practices.

Crop production, harvesting, handling, and storage activities all influence the exposure of produce to microbial hazards in some way. In agriculture, it is much easier to prevent produce from becoming contaminated than to sanitize it later and it is in the grower's interest to market high quality and safe food products.